

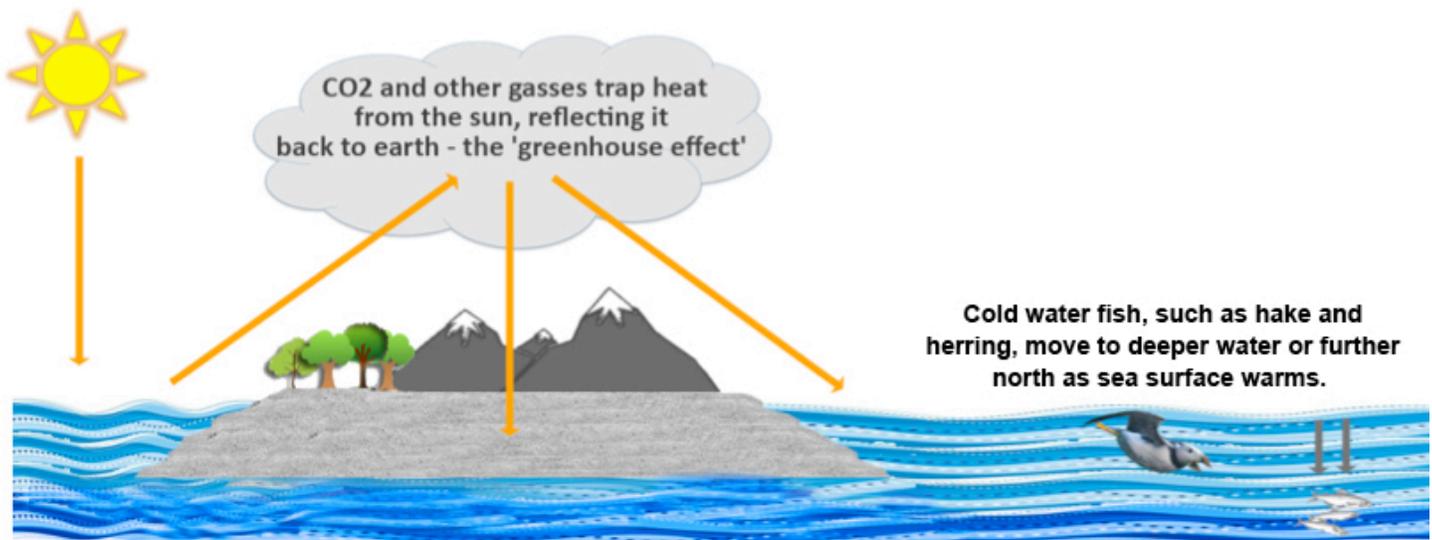
Maine Puffins Rebound

Cooler water and more phytoplankton in spring of 2014 favor return of favorite forage fish

Maine puffins experienced a dramatic increase in nesting success in 2014 following two years of food shortage for rearing chicks. But what does this tell us about changes in their ocean habitat?

How cooler water benefits puffins

As any Maine swimmer knows, frigid water is a hallmark of the state's coastal waters. Cold water that originates from melting ice in Greenland and the high Arctic may chill swimmers, but it also creates ideal temperatures for white hake and Atlantic herring—the puffins' most important forage fish. But recent warming of the sea surface has driven these fish northward into deeper, cooler water. Warmer water has also affected the timing of the spring phytoplankton bloom, which transfers the sun's energy up through the food chain, into the fish that puffins feed on, and to puffins themselves—along with a multitude of other ocean creatures.



Sunlight that reflects off of Earth's oceans is reflected back to land and water from 'greenhouse gases' (from burning fossil fuels), resulting in warmer water at the sea surface. Cold water puffin forage fish such as white hake and Atlantic herring may move to deeper water or move further north as a result—where they are no longer accessible to puffins. Warmer sea surface leads to more precipitation that reduces marine productivity (increased rain washes tiny organic particles from land into the surface water, blocking sunlight from phytoplankton).

This pattern became apparent when the "ocean heat wave" of 2012 raised Gulf of Maine sea surface temperatures to the warmest recorded level in the past 150 years. This warmer water not only displaced cold water fish, but favored the appearance of southern fish, including larger than usual butterfish—that were too big for puffin chicks to swallow. The effects of the heat wave continued into the summer of 2013, contributing to an undetectable plankton bloom, relatively few forage fish, and a nearly complete breeding failure for Maine puffins.



Puffin With Herring video link: <https://www.youtube.com/watch?v=lzCCBVBH6ws>

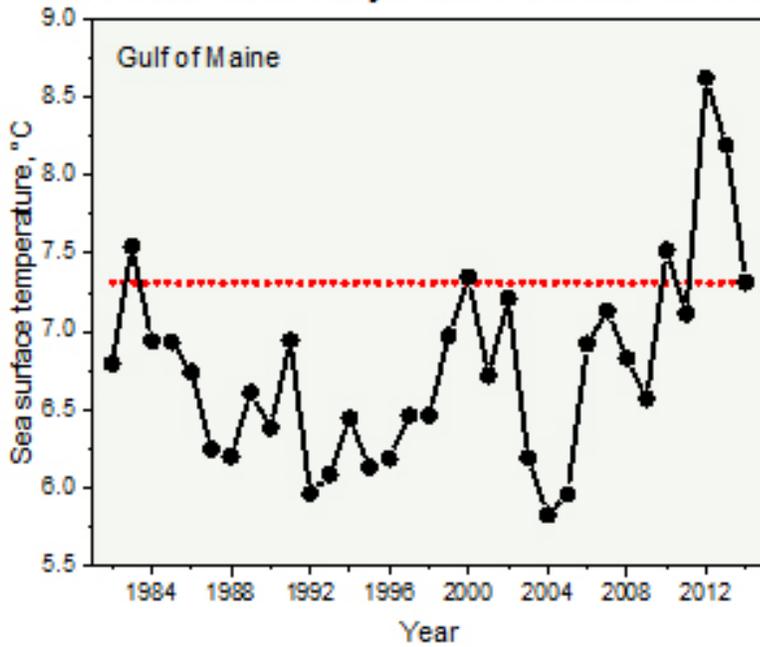
Photo and Video courtesy of Shawn P. Carey (Migration Productions)

The return to "normal"

The relatively cold winter of 2013-2014 resulted in a chilling of Maine's seawater, bringing the average sea surface temperature in the Gulf of Maine down by about 1.8 degrees Fahrenheit. This is the high end of recent normal sea surface temperatures during the first six months of 2014. This temperature helped to produce a weak plankton bloom in March and April that was sufficient to nurture ample food for puffins in the weeks prior to egg laying and sustain the forage fish necessary for chick rearing. This year Maine puffins began laying eggs during the last week of April, the normal beginning of egg-laying. Some puffins brought back impressive beak-loads of Atlantic herring to their chicks. This puffin landed briefly before slipping under boulders to feed its chick. Click the video link below the puffin photo above to see a video of the puffin with herring.

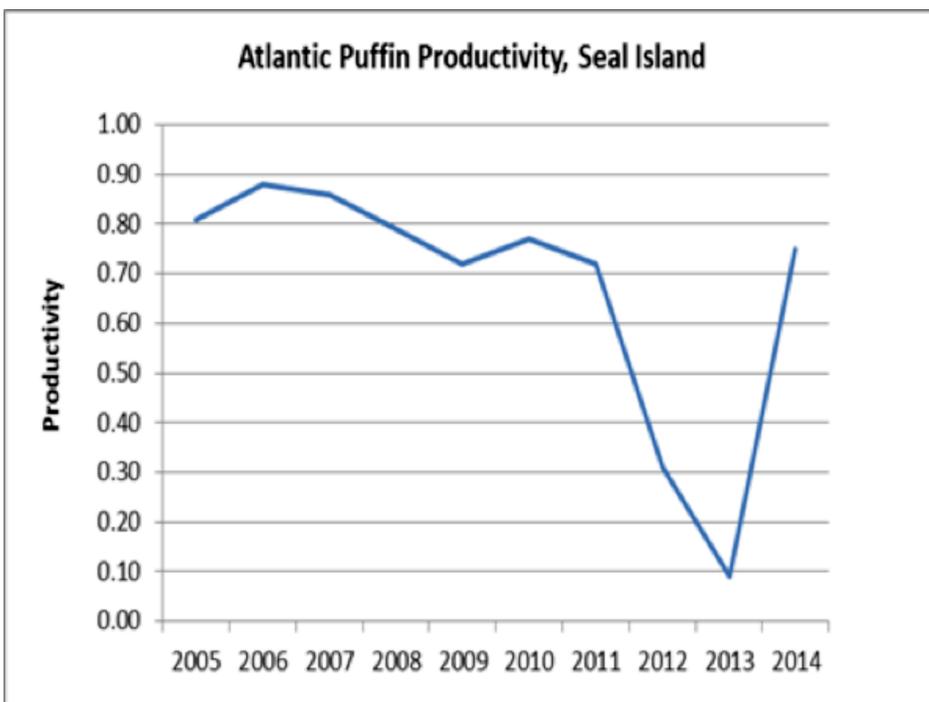
2014- return to 'normal'

First Half of the year SST 1982-2014



Graph courtesy of Kevin Friedland, NOAA

The 'Ocean Heat Wave' of 2012-13 resulted in a steep decline in puffin nesting success. In 2014, sea surface temperature (SST) returned to the high side of normal and this set the stage for a successful nesting season for puffins.



At Seal Island National Wildlife Refuge, puffin nesting success (chick fledged/pair) dropped to just 31% and 10% during 2012 and 2013. As SST decreased, nesting success increased dramatically in 2014.

Puffin eggs hatch six weeks after the egg is laid. The chick's first meals are usually tiny white hake and herring that have returned to the coastal waters to feast on the spring plankton—especially small copepods. Our researchers found that white hake and Atlantic herring made up 48% and 22% respectively of the puffin chicks' diet at Seal Island NWR last summer. Sand lance made up an additional 19% of the diet. Only a few butterfish were observed. The number of nesting puffins rebounded as a result; 84% of burrows were occupied by incubating adults, compared to just 68% in 2013. Seventy-five percent of these pairs fledged chicks; a dramatic improvement from 2013 when just one in ten pairs did so. The puffin season was similar at other Gulf of Maine colonies where 66% and 44% of puffin pairs at Matinicus Rock and Machias Seal Island respectively fledged young—a dramatic recovery from 2013 when less than 10% and 15% respectively fledged. White hake was by far the most important item as a percent of fish in the puffin chick's diet, but the larger size and bulk of herring and sand lance (though smaller proportion of meals) were also key to the chick's success.

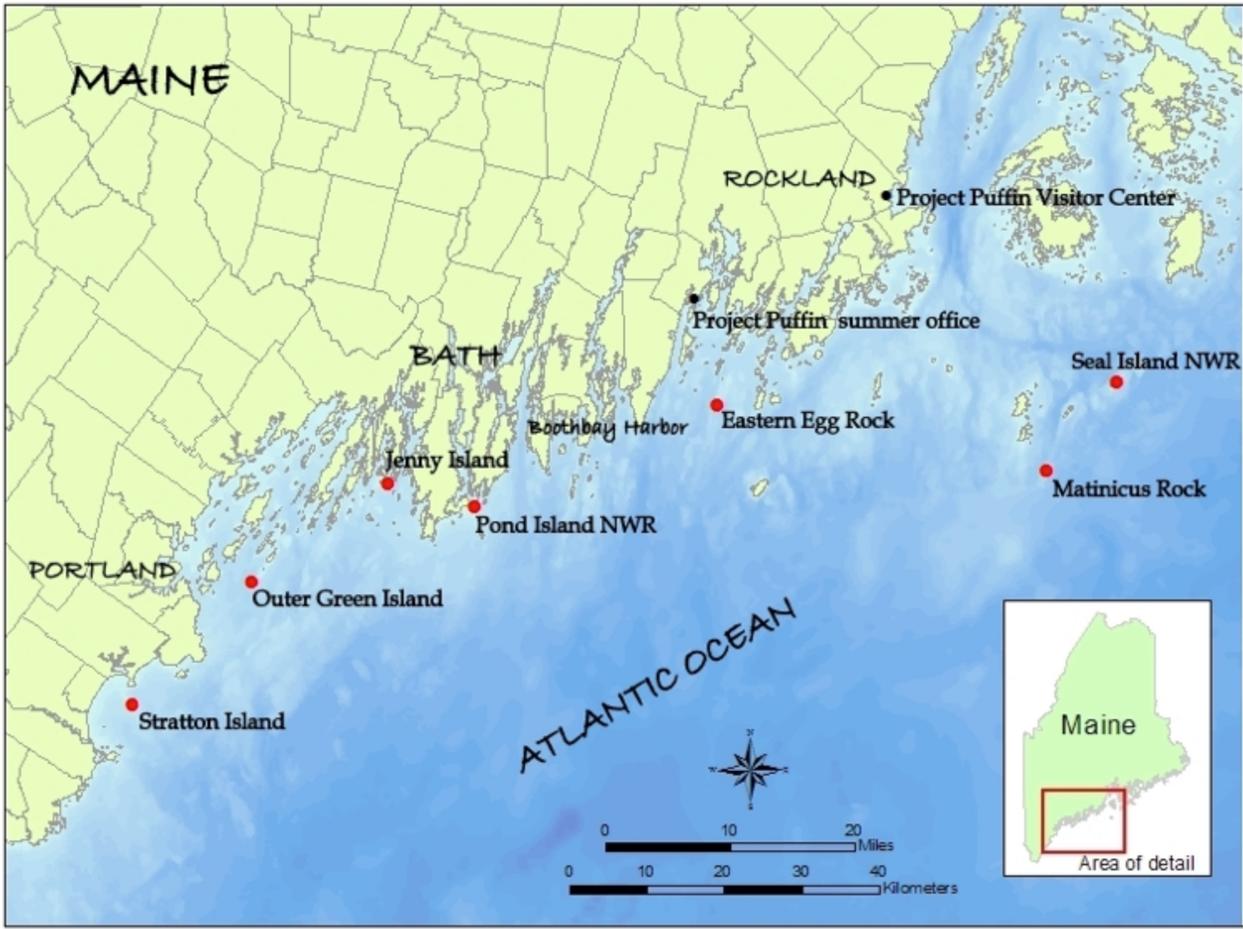
Burrow Cam Drama

The [Explore.org](#) puffin burrow cam also showed an increase in feedings. Viewers were rewarded by seeing frequent feedings to the 2014 puffin chick named "Pal" up until fledging time. By contrast, the 2013 cam chick (Hope) received fewer feedings and was among the relatively few chicks to successfully fledge. The 2012 cam puffin chick 'Petey' starved surrounded by large uneaten butterfish. Volunteer Julie Wallace and other cam watchers collected the [attached series of observations and photos of the 2014 burrow cam puffling](#). In this series of photos, the parents, Phoebe and Finn deliver mostly sand lance and a few hake in late June until about the 4th of July at which time the diet switched to herring (note the forked tail and broader shape). Many thanks to Julie Wallace, as well as all of the other 2014 [Explore.org](#) puffin burrow cam watchers, for their photographs and observations.

Eastern Egg Rock puffins also experienced an excellent year in 2014. This colony suffered from predation by river otters in 2012 and experienced just a 6% growth in 2013. Ample food in 2014 resulted in a 33% surge in nesting pairs to the new record high of 148 nesting puffin pairs.



Eastern Egg Rock puffins reached a record high number of breeding pairs in 2014. In 2012, predation by two river otters and the "ocean heat wave" resulted in the first big decline in puffin nesting pairs in 32 years. In contrast, 2014 was a banner year. *Puffin with white hake photo by Bob Bukaty.*



Seven Maine Field Stations of the Audubon Seabird Restoration Program

Top Four Puffin Foods at Maine Islands in 2014



Photo by Derrick.Z. Jackson

White Hake was by far the most numerous fish at all islands. Identified by their limp body, dark back, and pointed, unforked tail. White hake were by far the most common fish in puffin diet, making up 77% of fish delivered.



Photo by Stephen Kress

Atlantic Herring is the heaviest of the fish fed to puffin chicks and therefore carries more nutrition per fish than any other puffin forage fish. It was the second most common fish in the Seal Island puffin chick diet this summer. Identified by very silvery sides, moderate depth body and forked tail.



Photo by Derrick Z. Jackson

Redfish (*Sebastes, sp.*) is a new addition to the puffin's diet. The redfish (sometimes called Ocean Perch) population has increased in recent years due to successful fisheries management. It was the second most common food fed to chicks at Eastern Egg Rock. Identified by the broad side bands, chunky body and pointed tail.



Photo by Stephen Kress

Sand Lance was important in Maine puffin diet in 2014, but has been relatively scarce in their diet since 2007. Identified by long, narrow body.

Puffin diet at Maine islands. Ample white hake, sand lance and herring were provided this year.

